

1      Improvements in or Relating to Internal Combustion  
2      Engines

3

4      This invention relates to improvements in or  
5      relating to internal combustion engines, and in  
6      particular, but not exclusively, to improvements  
7      relating to replacement apparatus for the intake and  
8      exhaust valves of internal combustion engines.

9

10     Conventional four stroke internal combustion engines  
11    involve a four stage cycle. Firstly, there is an  
12    intake of air/fuel mixture into a cylinder; known as  
13    "intake stroke". Secondly, a piston within the  
14    cylinder compresses the air/fuel mixture; known as  
15    "compression stroke". Thirdly, the compressed  
16    air/fuel mixture is ignited in the cylinder causing  
17    combustion; known as "combustion stroke". And  
18    lastly, the combusted gases are exhausted; known as  
19    "exhaust stroke".

20

21     A four stroke internal combustion engine comprises  
22    an intake valve to allow an ingress of air/fuel

1 mixture into a cylinder, and an exhaust valve, to  
2 allow an egress of exhausted gases after combustion  
3 of the air/fuel mixture.

4

5 The timing of the opening and closing of the valves  
6 is vital to an engines performance.

7

8 To allow the piston to draw-in the fuel/air mixture  
9 (or air alone in the case of a direct injection  
10 engine), the intake valve needs to open as the  
11 piston moves from an extended position to a  
12 retracted position on the intake stroke.

13

14 The exhaust valve needs to be opened as the piston  
15 is extended in the exhaust stroke.

16

17 Both the intake and the exhaust valves each comprise  
18 a rocker arm and a valve return spring, with the  
19 rocker arm being actuated by a cam or a lobe located  
20 on a camshaft.

21

22 The valves act against the valve return springs,  
23 where the valves are fired in one direction, only  
24 then to stop at the extent of their travel, and be  
25 sent flying in the opposite direction. This happens  
26 many times a minute which wastefully drains power  
27 from the engine. This also causes noise, vibration  
28 and harshness.

29

30 As the camshaft rotates, the shape of the cam which  
31 actuates the rocker arm, determines the timing of  
32 the opening and closing of the intake and exhaust

1       valves.

2

3       Conventional designs of cams, particularly fixed  
4       cams, will only operate optimally over a limited  
5       range of speeds.

6

7       According to one aspect of the present invention, a  
8       cylinder head assembly comprises a cylinder head  
9       having an inlet passage and an outlet passage for  
10      communication, in use, with a cylinder, and at least  
11      one rotatably mounted shaft member interposed  
12      between the inlet and outlet passages and the  
13      cylinder, the shaft member(s) having passage means  
14      to allow an ingress of air mixture from the inlet  
15      passage to the cylinder at a first desired  
16      rotational position, and to allow an egress of  
17      combusted gases from the cylinder through the outlet  
18      passage at a second desired rotational position and  
19      to prevent the air or combusted gases from entering  
20      or exiting the cylinder at a third desired  
21      rotational position.

22

23      There may be two shaft members, one cooperating with  
24      the inlet passage and one with the outlet passage.

25

26      Preferably, the shaft members are coupled, in use,  
27      to a crankshaft with means for independently  
28      controlling or adjusting the speed of rotation of  
29      said shaft members.

30

31      Alternatively, the shaft members are driven  
32      independently of the crankshaft, and of each other,

1 with means for individually controlling or adjusting  
2 the speed of rotation of said shaft members.

3

4 The shaft member or each shaft member may be  
5 substantially solid, and the passage means may  
6 comprise a recess in the shaft member or a  
7 respective recess in each of the shaft members.

8

9 Alternatively, each shaft member may be hollow; each  
10 shaft member having at least one aperture located  
11 around a portion of its circumference, wherein the  
12 inlet shaft member allows an ingress of air/fuel  
13 mixture through the inlet shaft member to enter said  
14 cylinder when the aperture in the inlet shaft is  
15 presented to the cylinder, and the outlet shaft  
16 member allows an egress of combusted gases to exit  
17 the cylinder when the aperture in the outlet shaft  
18 member is presented to the cylinder.

19

20 Preferably each shaft member is provided with an  
21 inner hollow tube member rotatably mounted within  
22 said shaft member; each inner tube member having at  
23 least one aperture located around a portion of its  
24 circumference; rotation of said inner tube member  
25 within the respective hollow shaft members providing  
26 a variable size effective aperture, which allows a  
27 variable ingress of combustion air to enter said  
28 cylinder through the effective aperture in the inlet  
29 shaft member, and allows a variable egress of  
30 combusted gases from the cylinder to exit through  
31 the effective aperture in the outlet shaft member.

1 Preferably also, the speed of rotation of the inner  
2 and outer tube members are such that the effective  
3 aperture maximises or restricts the rate of ingress  
4 of air, or egress of exhaust gases, through the  
5 respective inner tube members.

6

7 The inner tube members may be coupled, in use, to a  
8 crankshaft with means for independently controlling  
9 or adjusting the speed of rotation of said tube  
10 members. Alternatively, the tube members may be  
11 driven independently of the crankshaft, and of each  
12 other, with means for individually controlling or  
13 adjusting the speed of rotation of said tube  
14 members.

15

16 Typically, the cylinder head assembly will form part  
17 of a multi-cylinder engine with the shaft member(s)  
18 extending over a number of cylinders, the shaft  
19 member(s) having a corresponding number of passage  
20 means.

21

22 The shaft member(s) suitably have gas tight seal  
23 assemblies.

24

25 From another aspect, the invention provides a method  
26 of allowing an ingress and egress of combustion air  
27 and combusted gases from a cylinder comprising the  
28 steps of:

29 presenting a passage means within a shaft  
30 member to an inlet passage;

31 retracting of a piston within a cylinder to  
32 allow an induction of air from the inlet passage

1 through said passage means into the cylinder;  
2 rotating the shaft member to prevent any  
3 leakage of air upon a compression of the air in the  
4 cylinder by the piston;  
5 combusting air/fuel mixture in the cylinder to  
6 cause said piston to retract;  
7 extending the piston in the cylinder;  
8 presenting passage means to the cylinder and  
9 an outlet passage to allow an egress of combusted  
10 gases; and  
11 repeating the above steps.

12

13 In one form of the method, the same passage means is  
14 used for induction and egress.

15

16 The passage means may be formed by an aperture in at  
17 least one hollow shaft, and the method further  
18 includes the step of varying the effective size of  
19 the aperture to restrict or maximise the amount of  
20 fluid flow through the aperture.

21

22 Embodiments of the present invention will now be  
23 described, by way of example only, with reference to  
24 the accompanying drawings in which:-

25

26 Fig. 1 is a schematic front sectional view of a  
27 conventional four stroke internal combustion  
28 engine;

29

30 Figs. 2a-d are schematic front sectional views  
31 illustrating the workings of a single rotatably  
32 mounted shaft member of the present invention;

1       Figs. 3a-d are schematic front sectional views  
2       illustrating the workings of an alternative  
3       embodiment with two rotatably mounted shaft  
4       members;

5

6       Figs. 4a and 4b are a side view and perspective  
7       side view respectively (shown schematically) of  
8       an alternative shaft member;

9

10      Fig. 5 is a schematic plan view of further  
11      alternative shaft members;

12

13      Fig. 6 is a schematic plan view of shaft member  
14      embodiments applied to more than one cylinder;

15

16      Fig. 7 is a schematic perspective view of  
17      apparatus of a first embodiment;

18

19      Fig. 8 is a schematic perspective view of  
20      apparatus of a second embodiment; and

21

22      Fig. 9 is a schematic perspective view of  
23      apparatus of a third and fourth embodiment;

24

25      With reference to the drawings, and in particular  
26      Fig. 1, there is shown conventional apparatus of a  
27      four stroke internal combustion engine 10.

28

29      The conventional engine 10 comprises the known  
30      element of a cylinder 12 which houses a piston M  
31      which is movably sealed therein.

32

1      The piston M is attached to a crankshaft P by a  
2      connecting rod N and rod bearing O. The crankshaft  
3      P serves to convert the up and down motion of the  
4      piston M into rotational motion; which is utilised  
5      to turn wheels of a vehicle, propellers of a vessel  
6      or aircraft.

7

8      The conventional engine 10 also comprises the known  
9      element of a cylinder head D having an intake valve  
10     assembly A and an exhaust valve assembly J which are  
11     both intermittently actuated by a camshaft I.  
12     Both valve assemblies A, J have rocker arms 14, 18  
13     with corresponding springs 16, 20, and conventional  
14     poppet valves 22, 24.

15

16     On the intake stroke of a four stroke engine 10, the  
17     intake valve assembly A is open to allow an ingress  
18     of air/fuel mixture into the cylinder 12 via an  
19     intake port C.

20

21     Meanwhile, the exhaust valve assembly J is closed.  
22     The piston M will retract drawing the air/fuel  
23     mixture into the cylinder 12.

24

25     The piston M retracts by virtue of stored energy  
26     being transferred from a flywheel (not shown) to the  
27     piston M via the crankshaft P.

28

29     It should be understood that on all "non-power  
30     strokes", namely, retraction of the piston M on the  
31     intake stroke, compression of the air/fuel mixture,  
32     and exhausting of the combusted gases, the energy

1 required to drive the piston M is transferred from  
2 the flywheel to the connected crankshaft P.

3

4 As the piston M bottoms out it will change direction  
5 and extend within the cylinder 12. Closure of the  
6 intake valve assembly A allows for the air/fuel  
7 mixture to be compressed within the cylinder 12;  
8 referred to as "compression stroke".

9

10 Again, the exhaust valve assembly J is closed.

11

12 When fully compressed, a spark plug K extending into  
13 the cylinder 12, ignites the compressed mixture to  
14 cause combustion.

15

16 Alternatively, in a diesel engine, the heat caused  
17 by compressing the air/fuel mixture alone will  
18 result in combustion.

19

20 The resultant combustion produces an excess of gases  
21 which force the piston M to retract within the  
22 cylinder 12.

23

24 The exhaust valve assembly J is opened as the piston  
25 M bottoms out to allow an egress of the combusted  
26 gases through an exhaust port L; referred to as  
27 "exhaust stroke".

28

29 As the piston M returns to an extended position, the  
30 exhaust valve assembly J is closed, whereas the  
31 intake valve assembly A is open to start the cycle  
32 again and allow in ingress of air/fuel mixture.

1     It will be realised that the timing of the opening  
2     and closing of the valve assemblies A, J will have a  
3     large bearing on the performance of the engine 10.  
4     If either of the valve assemblies A, J are open on  
5     the compression stroke, then the air/fuel mixture  
6     will not be fully compressed resulting in poor  
7     performance of the engine 10.

8

9     Lobes or cams 26 located on the camshaft I are  
10    designed to intermittently open and close each of  
11    the valve assemblies A, J as and when required.

12

13    It will be realised however, that (fixed) cams 26 of  
14    a particular design operate optimally for a given  
15    range of speeds only.

16

17    The rocker arms 14, 18 act against the corresponding  
18    valves 22, 24 and valve return springs 16, 20. The  
19    valves 22, 24 are fired in one direction, only then  
20    to stop at the extent of their travel, and be sent  
21    flying in the opposite direction. This happens many  
22    times a minute which wastefully drains power from  
23    the engine 10 and can cause noise, vibration and  
24    harshness.

25

26    In a first embodiment of the present invention, as  
27    illustrated in Figs. 2a-d and Fig. 7, there is  
28    provided apparatus 100 in the form of a cylinder  
29    head assembly comprising a cylinder head D adapted  
30    with a valve assembly replacement shaft member 110  
31    rotatably mounted.

32

1     The shaft member 110 is of the form of a cylindrical  
2     rod with a recess 112 removed around a portion of  
3     the circumference of the shaft member 110 and along  
4     that part of its length which is presented to  
5     (above) the cylinder 12.

6

7     It is to be understood that the shaft member 110 and  
8     recess 112 are presented facing the cylinder  
9     irrespective of the cylinder's orientation; for  
10    example, it may be a horizontal engine, in which  
11    case the recess 112 is presented adjacently facing  
12    the cylinder 12.

13

14    The shaft member 110 is rotatably mounted in the  
15    cylinder head D.

16

17    The shaft member 110 is parallel with, and is co-  
18    operatively driven by, the crankshaft P by virtue of  
19    connecting means (not shown) in the form of a belt  
20    or gearing 114.

21

22    The recess 112 serves to allow an ingress or egress  
23    of air/fuel mixture or exhaust gases to and from the  
24    cylinder 12 upon rotation of the shaft member 110.

25

26    The depth and length of the recess 112 presented to  
27    (above) the cylinder 12 can be of any design and  
28    dimensions to allow optimum ingress and/or egress of  
29    air/fuel mixture and/or combusted gases to and from  
30    the cylinder 12; for example, the recess 112 may be  
31    of uniform depth and length or may have varying

1      depths or lengths, or the recess 112 may also be of  
2      the form of a helix, etc.

3

4      In operation, as shown in Fig. 2a and Fig. 7, there  
5      is an inlet of air from an inlet manifold 116 which  
6      is coupled to a carburettor/fuel injector (not  
7      shown) to form an air/fuel mixture.

8

9      The shaft member 110 is presented such that the  
10     recess 112 faces the intake port C and the cylinder  
11     12 to allow an ingress of air/fuel mixture.

12

13     Rotation of the crankshaft P, initially caused by a  
14     starter motor (not shown) then subsequently by the  
15     transfer of energy from the flywheel, causes contra-  
16     rotation of the shaft member 110 by virtue of  
17     contra-connecting means (not shown) being connected  
18     to the crankshaft P and gearing 114 on the shaft  
19     member 110.

20

21     Rotation of the crankshaft P will cause the piston M  
22     to retract, drawing-in the air/fuel mixture through  
23     the inlet port C, into the cylinder 12.

24

25     Meanwhile, as the piston M is retracted by virtue of  
26     the rotating crankshaft P, the recess 112 of the  
27     shaft member 110 will contra-rotate in unison.

28

29     As the piston M bottoms out, the rotating shaft  
30     member 110 and recess 112 face the intake port C and  
31     the cylinder head D. Thus preventing any ingress or

1 leakage of air/fuel mixture on the compression  
2 stroke, as shown in Fig. 2b.

3

4 On the compression stroke, the piston M is extended  
5 to compress the air/fuel mixture as the crankshaft P  
6 and interconnected shaft member 110 similarly  
7 rotate, as shown in Fig. 2c.

8

9 The recess 112 faces the cylinder head D and the  
10 exhaust port L.

11

12 A spark plug K (not shown for convenience in Figs.  
13 2a-d), ignites the compressed air/fuel mixture in  
14 the cylinder 12.

15

16 Alternatively, in a diesel engine, the heat caused  
17 by compressing the air/fuel mixture alone will  
18 result in combusted gases.

19

20 The resultant combustion causes the piston M to be  
21 fired to a retracted position causing the crankshaft  
22 P and shaft member 110 to rotate.

23

24 The recess 112 meanwhile, will rotate facing both  
25 the exhaust port L and cylinder 12 to allow the  
26 piston M to extend exhausting the combusted gases  
27 out through the recess 112 into the exhaust port L.

28

29 Upon exhaustion of the combusted gases, rotation of  
30 the crankshaft P will cause the recess 112 to rotate  
31 and face the cylinder 12 and inlet port C to allow  
32 the cycle to begin again.

1 As the rotation of the crankshaft P and shaft member  
2 112 are rotating opposite to one another, this will  
3 have a balancing effect which may reduce noise and  
4 vibration of the engine 10.

5

6 To prevent any unburnt fuel being expelled with the  
7 exhaust gases, fuel injectors (not shown) may be  
8 used to control the flow of fuel into the separate  
9 branches of the inlet manifold. The fuel injectors  
10 would be closed before the recess 112 closes, such  
11 that no unburnt fuel would be exhausted by being  
12 trapped in the recess 112 as the shaft 110 rotates.  
13 Alternatively, the fuel injectors may directly  
14 inject the fuel into the cylinder 12. Hence, only  
15 air would therefore pass through the manifold, via  
16 the recess 112 into the cylinder 12, avoiding  
17 unburnt fuel being trapped in the recess 112, and  
18 being exhausted as the shaft 110 rotates.

19

20 In a second embodiment of the present invention, as  
21 shown in Figs. 3a-d and Fig. 8, there is provided  
22 apparatus 200 in the form of a cylinder head  
23 assembly comprising a cylinder head D having two  
24 valve assembly replacement shaft members, namely, an  
25 intake shaft member 210 and an exhaust shaft member  
26 212 which are rotatably mounted.

27

28 The shaft members 210, 212 are of the form as  
29 described above with recesses 214, 216 as also  
30 described above.

31

1      The shaft members 210, 212 are rotatably mounted in  
2      the cylinder head D as before.

3

4      The shaft members 210, 212 are parallel with, and  
5      are co-operatively driven by, the crankshaft P by  
6      connecting means (not shown) coupled to gearing 114.

7

8      Alternatively, the shaft may be belt driven from the  
9      crankshaft P.

10

11     The recesses 214, 216 are as described above, and  
12    serve to allow an ingress of air/fuel mixture and an  
13    egress of combusted gases respectively, into the  
14    cylinder 12 upon rotation of the crankshaft P and  
15    shaft members 210, 212.

16

17     The depth and length of the recesses 214, 216  
18    presented to (above) the cylinder 12 can be of any  
19    design and dimensions to allow optimum ingress and  
20    egress of air/fuel mixture and combusted gases to  
21    and from the cylinder 12; for example, the recesses  
22    214, 216 may be of uniform depth and length or may  
23    have varying depths or lengths, or they may be of  
24    the form of a helix, etc.

25

26     In operation, as shown in Fig. 3a, the intake shaft  
27    member 210 is rotated, by the crankshaft P, to face  
28    the intake port C and the cylinder 12 to allow an  
29    ingress of air/fuel mixture.

30

31     Meanwhile, the exhaust shaft member 212 faces the  
32    exhaust port L and cylinder head D thus preventing

1 air/fuel mixture to leave the cylinder 12 or air to  
2 enter therein.

3

4 As the air/fuel mixture enters the cylinder 12 from  
5 the intake port C, the crankshaft P rotates causing  
6 the piston M to retract, causing the shaft members  
7 210, 212 and hence recesses 214, 216, to rotate in  
8 unison by virtue of them being interconnected by  
9 connecting means to the gearing 114.

10

11 As the piston M begins to extend, the recess 214  
12 rotates to face the cylinder 12 and cylinder head D.  
13 Thus preventing any ingress or leakage of air/fuel  
14 mixture from the cylinder 12 on the compression  
15 stroke, as shown in Fig. 3b.

16

17 Meanwhile, the exhaust shaft member 212 will  
18 likewise have rotated with the recess 216 now facing  
19 the cylinder head D completely. Thus preventing an  
20 ingress of air or an egress of air/fuel mixture.

21

22 On the compression stroke, the crankshaft P rotates  
23 causing the piston M to extend compressing the  
24 air/fuel mixture. The interconnected shaft members  
25 210, 212 and recesses 214, 216 similarly rotate.

26

27 As the piston M becomes fully extended on the  
28 compression stroke, the intake recess 214 at this  
29 point completely faces the cylinder head D and is  
30 thus closed off preventing any egress of compressed  
31 air/fuel mixture, as shown in Fig. 3c.

32

1 A spark plug K (not shown for convenience in Figs.  
2 3a-d), ignites the compressed air/fuel mixture in  
3 the cylinder 12.

4

5 Alternatively, in a diesel engine, the heat caused  
6 by compressing the air/fuel mixture alone will  
7 result in combustion.

8

9 The resultant combustion causes the piston M to be  
10 fired to a retracted position causing the crankshaft  
11 P and shaft members 210, 212 to rotate.

12

13 The intake recess 214 will rotate facing both the  
14 cylinder head D and the intake port C.

15

16 The exhaust recess 216 will rotate facing the  
17 cylinder 12 and exhaust port L to allow an egress of  
18 combusted gases, as shown in Fig. 3d.

19

20 The piston M then extends exhausting the combusted  
21 gases out through the recess 216 into the exhaust  
22 port L by virtue of the rotating crankshaft.

23

24 Meanwhile, rotation of the crankshaft P will cause  
25 the intake recess 214 to rotate and face the inlet  
26 port C and the cylinder 12 to allow the cycle to  
27 begin again.

28

29 The exhaust recess 216 will likewise rotate facing  
30 the exhaust port L and the cylinder head D, as shown  
31 in Fig. 3a.

32

1       In a third embodiment of the present invention there  
- 2      is provided apparatus 400, as shown in Figs. 5 and  
3      9, having apparatus 200 as previously described in  
4      the second embodiment, wherein the intake shaft  
5      member 210 and the exhaust shaft member 212 are of  
6      the form of a hollow cylindrical intake shaft member  
7      410 and a hollow cylindrical exhaust shaft member  
8      412.

9

10     In this way, it should be realised that the heavy  
11    intake manifold (not shown) and outlet manifold 116,  
12    can be replaced by single, less heavy and  
13    complicated manifolds 418, 420, which allow the  
14    ingress of air/fuel mixture and egress of combusted  
15    gases through the hollow shaft members 410, 412.

16

17     The shaft members 410, 412 are presented to (above)  
18    the cylinder 12 to allow an ingress of air/fuel  
19    mixture thereto through aperture 414, and an egress  
20    of exhaust gases therefrom through aperture 416.

21

22     In this third embodiment, the air/fuel mixture  
23    passes through the hollow intake shaft member 410  
24    and exits through the aperture 414 into the cylinder  
25    12.

26

27     After the compression and combustion strokes, the  
28    exhaust gases exit the cylinder 12 through the  
29    aperture 416 and leave via the hollow exhaust shaft  
30    member 412.

31

32     The shaft members 410, 412 are connected to the

1 crankshaft P by connection means (not shown) coupled  
2 to gearing 114.

3

4 Alternatively, the shaft members 410, 412 may be  
5 coupled to the crankshaft P by a belt.

6

7 It is conceived that rotation of the shaft members  
8 410, 412 although specifically described as being  
9 coupled to and controlled by the crankshaft P, may  
10 be independently and controllably adjustable.

11

12 Furthermore, both shaft members 410, 412 may be  
13 driven independently of the crankshaft P and of each  
14 other.

15

16 In a fourth embodiment of the present invention,  
17 there is provided apparatus 200 wherein the shaft  
18 members 210, 212 are of the form of hollow shaft  
19 members 300, as shown in Figs. 4a and 4b.

20 Each shaft member 300 has an inner hollow  
21 cylindrical tube 310, rotatably mounted within an  
22 outer hollow cylindrical tube 312, also rotatably  
23 mounted.

24

25 The tubes 310, 312 have apertures 314, 316 which  
26 correspondingly serve to allow an ingress of  
27 air/fuel mixture and egress of exhaust gases to pass  
28 therethrough.

29

30 The apertures 314, 316, when appropriately aligned,  
31 form a passage 326.

32

1      The area of the passage 326 is adjusted and  
2      controlled by the speed of rotation of the tubes  
3      310, 312 relative to one another.

4

5      Rotation of the tubes 310, 312 is controlled by  
6      gears 318, 320 located around the circumference of  
7      respective cylindrical buttressed ends 322, 324 of  
8      the tubes 310, 312.

9

10     Rotation of the tubes 310, 312 may be coupled to the  
11    crankshaft P with independently controllable/  
12    adjustable means for varying the speed of rotation  
13    of the tubes 310, 312.

14

15     Alternatively, both tubes 310, 312 may be driven  
16    independently of the crankshaft P and of each other,  
17    with controllable/ adjustable means for varying the  
18    speed of rotation of the tubes 310, 312.

19

20     It will be recognised that the tubes 310, 312 may  
21    also be belt driven or the like, independently of,  
22    or coupled to, the crankshaft P.

23

24     The speed of rotation of the inner tube 310,  
25    relative to the outer tube 312, is such that the  
26    area of the passage 326 maximises or restricts the  
27    rate of ingress or egress of air/fuel mixture or  
28    exhaust gases. In this way, the rotatable shaft  
29    members 300 offer a variable valve timing and  
30    variable valve size.

31

32     With reference to Figs. 4a and 4b, it is to be

1 understood that both tubes 310, 312 do not move  
2 horizontally/longitudinally. The apertures 314, 316  
3 share a common centre-line C/L, and are shown offset  
4 for illustrative purposes only.

5

6 Common to all embodiments and with regard to sealing  
7 of the various shaft members 110, 210, 212, 310,  
8 312, 410, 412 of the present invention, these will  
9 be as tight a fit as possible cognisant of the  
10 expansion of materials of the individual,  
11 respective, components that will occur once the  
12 engine reaches working temperature.

13

14 The shaft members 110, 210, 212, 310, 312, 410, 412  
15 include gas tight seals (not shown) incorporated on  
16 the outside faces of bearing races (not shown), of  
17 support bearings (not shown), that will be spaced  
18 along the rotating shaft members 110, 210, 212, 310,  
19 312, 410, 412 between the cylinder 12.

20

21 Gas tight paddles (not shown) are located within  
22 apertures (not shown) of the shaft members 110, 210,  
23 212, 310, 312, 410, 412, at either side of the  
24 respective recesses and apertures 112, 214, 216,  
25 314, 316, 414, 416, of the axis of rotation.

26

27 Springs (not shown) are located at the base of the  
28 paddles within the apertures. These serve to force  
29 the paddles outwards towards and against the inside  
30 surfaces of the cylinder head D, within which the  
31 shaft members rotate, so ensuring a gas tight seal  
32 in a similar way to the WANKEL rotary engine.

1 Common to all embodiments, it should be realised  
2 that the shaft members 110, 210, 212, 310, 312, 410,  
3 412 may be of the form of extended or adapted shaft  
4 members 510, 512, rotatably mounted, with a  
5 plurality of recesses or apertures 514, 516  
6 corresponding to the number of cylinders 12, as  
7 shown in Fig. 6.

8

9 Furthermore, the recesses 112, 214, 216 and  
10 apertures 314, 316, 414, 416 of the corresponding  
11 shaft members 110, 210, 212, 310, 312, 410, 412 can  
12 be as wide as the diameter of the cylinder 12 above  
13 which they sit. This means that a far greater area  
14 will be available for an ingress of air/fuel mixture  
15 or egress of exhausted gases, than might be  
16 associated with conventional valves.

17

18 The hollow intake shaft members (310, 312,) 410, 510  
19 may form an integral part of an inlet system (not  
20 shown), or may feed into, much simplified, single  
21 branch manifolds 418, at the respective open end of  
22 the shaft members (310, 312), 410, 510 at an end of  
23 the cylinder head D.

24

25 The hollow exhaust shaft members (310, 312), 412,  
26 512 may form an integral part of an exhaust system  
27 (not shown), or may feed into, much simplified,  
28 single branch manifolds 420, at respective open ends  
29 of the shaft members (310, 312), 412, 512 at an end  
30 of the cylinder head D.

31

32 In this way, the air/fuel mixture and exhaust gases

1 would not be required to travel via individual  
2 openings within the cylinder head D to individual,  
3 heavy, complicated, and expensive multiple branches  
4 of intake/exhaust manifolds, feeding the  
5 intake/exhaust ports C, L to each cylinder 12.

6

7 The present invention as described, has a reduced  
8 size compared to a conventional engine 10 and offers  
9 greater flexibility to the location, installation,  
10 and utilisation of internal combustion engines.

11

12 The simpler design will have favourable implications  
13 as to complexity, overall size of the engine,  
14 efficiency, noise and reliability, finance of raw  
15 materials, manufacturing, etc.

16

17 For the sake of clarity, it should be understood  
18 that fuel injectors/carburettors, and the spark  
19 plug, have been omitted from Figs. 2a-d and 3a-d but  
20 may be part of the cylinder head assembly.

21

22 The foregoing description refers to the induction of  
23 air/fuel mixture, as will be the case where a  
24 carburettor or manifold fuel injection is used. It  
25 will be appreciated that the invention may equally  
26 be applied to direct fuel injection engines, in  
27 which case the induction will be of charge air  
28 without fuel.

29

30 Modifications and improvements may be made to the  
31 above without departing from the scope of the  
32 present invention.